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(54) Connector for coupling optical fibres.

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Description

The invention relates to a connector for optically coupling at least one pair of optical fibres, end portions of which are accommodated in envelopes having a circular-cylindrical outer surface, which connector includes a coupling sleeve for coaxially accommodating at least the free end portions of the two envelopes for optically interconnecting the optical fibres *via* their end faces, which coupling sleeve includes a central cavity which extends in its longitudinal direction and which is shaped as a prism whose cross-section is triangular and whose inscribed circle has a diameter which is smaller than the diameter of the outer surface of the envelope, the walls of the central cavity being disposed so as to be resilient in the radial direction so that the envelopes can be clamped in the central cavity.

A connector of this kind is known from US—A—4,193,665. The coupling sleeve of this known connector consists of a thin-walled cylindrical tube whose walls are deformed in their mid-region so as to form the prismatic central cavity. Such coupling sleeves are particularly suitable for the optical coupling of fibre bundles in which a large number of optical fibres are accommodated in a common envelope. In applications where each end portion of an optical fibre is accommodated in an envelope, the accuracy with which the two envelopes are positioned and retained on a common axis is usually insufficient, notably when so-called monomode fibres are concerned.

This is probably due to the fact that when one of the three walls of the central cavity is deformed at a point, such deformation may influence all points of all three walls.

It is an object of the invention to improve a connector of the kind set forth so that the three walls of the central cavity of the coupling sleeve are substantially independently resilient, so that the envelopes are more accurately positioned in the central cavity. To this end, the connector in accordance with the invention is characterized in that the walls of the central cavity are formed by free end portions of three leaf springs which are substantially independently resilient and whose non-free ends are regularly distributed around the circumference of the coupling sleeve and secured to the wall of a housing which encloses the central cavity, the planes of said leaf springs enclosing angles of approximately 60° with respect to each other, the thickness of the housing being large compared with the thickness of the leaf springs.

In order that the portions of each leaf spring which cooperate with the two envelopes to be introduced into the central cavity may be substantially independent of each other, a preferred embodiment of the connector in accordance with the invention is characterized in that approximately halfway along the central cavity each leaf spring is interrupted by a cut which extends in the radial direction from the free end to approximately the wall of the housing.

The coupling sleeve has a high mechanical stability and can be very inexpensively manufactured in a further preferred embodiment which is characterized in that the leaf springs and the housing are made from one piece of material. To this end, the coupling sleeve can be manufactured, for example from a bar of solid material by spark erosion, or it can be extruded.

The invention will be described in detail hereinafter with reference to the drawings. Therein:

Figure 1 is a longitudinal sectional view of an embodiment of a connector in accordance with the invention shown accommodating an envelope of an end portion of an optical fibre, and

Figure 2 is a cross-sectional view of a part of the connector, taken along the line II—II in Figure 1.

The connector for optically coupling a pair of optical fibres which is partly shown in Figure 1 includes a connector housing 1, for example made of plastics, in which a coupling sleeve 3 is secured. The connector housing itself is known and because it is of no importance for a proper understanding of the present invention, it is merely schematically indicated in the Figure. Figure 1 shows an end portion 5 of an optical fibre 7 which is accommodated in an envelope 9 having a circular-cylindrical outer surface 11. The protective coating 13 surrounding the optical fibre 7 has been removed from the end portion 5. It is secured in the envelope 9, for example by means of glue (not shown). The outer surface 11 of the envelope 9 is made substantially concentric with the light-conductive core (not shown) of the fibre 7, for example by using the method described in US—A—4,289,374 (PHN 9235). The end face 15 of the optical fibre 7 is polished and is perpendicular to the axis of the outer surface 11.

The coupling sleeve 3 includes a tubular housing 17 (see also Figure 2) in which there is provided a central cavity 19 which extends in the longitudinal direction of the coupling sleeve and which is bounded by three walls 21 which are formed by the free end portions of three leaf springs whose non-free ends are attached to the wall of the housing so as to be integral therewith. The planes of the three leaf springs 21 enclose angles of approximately 60° with respect to each other and the locations in which they are attached are regularly distributed around the circumference of the coupling sleeve 3 at angular distances of approximately 120° so that the central cavity 19 is shaped as a prism whose cross-section has the form of a triangle whose inscribed circle is denoted by a dash/dot line in Figure 2. The diameter of the inscribed circle 23 is smaller than the diameter of the circular-cylindrical outer surface 11 of the envelope 9 whose circumference is denoted by a dashed circle 25 in Figure 2 for the purpose of comparison. Approximately halfway along the central space 19 each leaf spring 21 is interrupted by a cut 27 which extends in the radial direction from the free end of the leaf spring to approximately the wall of the housing 17. As a result of this cut each leaf spring consists of two independently resilient portions which are situated in different halves of the coupling sleeve 3. When the free end portion of an envelope 9 with an end portion 5 of an optical fibre 7 is introduced into the central cavity 19 of the coupling sleeve 3 from the right-hand side (see Figure 1), the right-hand portions of the three leaf springs are resiliently deflected outwards to accommodate the outer surface 11 of the envelope. Due to this movement (denoted by arrows 29 in Figure 2) the cross-section of the central cavity 19 is increased so that the inscribed circle 23 is replaced by the inscribed circle 25 which has the same centre but whose diameter is equal to the diameter of the outer surface 11. The envelope 9 is thus clamped in the central cavity 19, its axis being coincident with the axis of the central cavity. When the free end portion of a similar envelope with an optical fibre is introduced into the central cavity 19 of the coupling sleeve 3 from the left-hand side, the left-hand portions of the three leaf springs 21 are resiliently deflected outwards in the same way, so that this envelope is also clamped in the central cavity, its axis being coincident with the axis of the central cavity and hence also with the axis of the envelope 9 shown in Figure 1. By sliding both envelopes into the coupling sleeve until the end faces 15 of the two optical fibres 7 contact each other, optical contact between the fibre cores joined is achieved *via* these end faces.

Figure 2 shows that the wall thickness of the housing 17 is comparatively large so that the housing is rigid in comparison with the leaf springs 21. Therefore, the three leaf springs 21 are independently resilient with respect to each other, so that the envelopes 9 are very accurately positioned. As a result of the presence of the cuts 27, moreover, the two portions of each leaf spring are also independently resilient so that the accuracy of positioning is further increased. Thanks to this step, differences between the diameters of the outer surfaces of the two envelopes will not influence the accuracy of core alignment. However, it is to be noted that the cut 27 may be omitted in some cases.

As appears from Figure 2, the coupling sleeve 3 is preferably made from a single piece of material. This can be achieved, for example by extruding it to the desired shape. Another suitable method of forming the coupling sleeve consists in spark erosion of a solid rod. However, it is alternatively possible to manufacture the housing 17 and the leaf springs 21 separately and to secure the leaf springs, for example in axial slots in the inner wall of the housing by means of glue or by welding.

When the material properties of the leaf springs 21 are constant over the entire length of the coupling sleeve, the spring characteristic will depend only on the dimensions of their cross-section (notably their thickness). The force with which the envelopes are clamped in the coupling sleeve, therefore, also depends on this cross-section. Consequently, this force can be varied as desired by a suitable choice of the cross-section. When the cross-sections of the three leaf springs deviate slightly from each other, the axes of the two envelopes will not coincide with the axis of the coupling sleeve, but the deviation will be the same for both envelopes, provided that the cross-section of each spring is constant over the entire length of the coupling sleeve. As a result, the axes of the two envelopes will be aligned, even though the centre of the circle 23 in Figure 2 is no longer situated on these axes.

Only one coupling sleeve 3 is shown in the connector housing 1 of the described embodiment and the envelope 9 accommodates only one optical fibre 7. However, each envelope may alternatively enclose a bundle of optical fibres so that a larger number of pairs of fibres will be coupled. The connector housing 1 may also comprise more than one coupling sleeve 3 for the optical coupling of more than one pair of optical fibres.

Claims

1. A connector for optically coupling at least one pair of optical fibres (7), end portions of which are accommodated in envelopes (9) having a circular-cylindrical outer surface (11), which connector includes a coupling sleeve (3) for coaxially accommodating at least the free end portions of the two envelopes for optically interconnecting the optical fibres *via* their end faces (15), which coupling sleeve incudes a central cavity (19) which extends in its longitudinal direction and which is shaped as a prism whose cross-section is triangular and whose inscribed circle (23) has a diameter which is smaller than the diameter of the outer surface (25) of the envelope, the walls of the central cavity being disposed so as to be resilient in the radial direction so that the envelopes can be clamped in the central cavity, characterized in that the walls of the central cavity are formed by free end portions of the three leaf springs (21) which are substantially independently resilient and whose non-free ends are regularly distributed around the circumference of the coupling sleeve and secured to the wall of a housing (3) which encloses the central cavity, the planes of said leaf springs enclosing angles of approximately 60° with respect to each other, the thickness (3) of the housing being large compared with the thickness of the leaf springs (21).

2. A connector as claimed in Claim 1, characterized in that about halfway along the central cavity each leaf spring (21) is interrupted by a cut which extends in the radial direction from the free end to approximately the wall of the housing.

3. A connector as claimed in Claim 1 or 2, characterized in that the leaf springs and the housing are made from one piece of material.

Patentansprüche

1. Verbindungselement zur optischen Kupplung mindestens eines Parres optischer Fasern (7), von denen Endteile in Hüllen (9) mit einem kreiszylinderförmigen Außenmantel (11) aufgenommen sind, wobei dieses Verbindungselement eine Kupplungsbüchse (3) aufweist zum koaxialen Auf-

nehmen mindestens der freien Endteile der beiden Hüllen, damit die optischen Faser über ihre Endflächen (15) optisch miteinander verbunden werden, wobei die Kupplungsbüchse eine sich in der Längsrichtung erstreckende zentrale Ausnehmung (19) in Form eines Prismas aufweist, dessen Querschnitt die Form eines Dreiecks hat und dessen Inkreis (23) einen Durchmesser hat, der kleiner ist als als der Durchmesser des Außenmantels (11) der Hülle, wobei die Wände der zentralen Ausnehmung derart ausgebildet sind, daß sie in radialer Richtung federnd sind, so daß die Hüllen klemmend in die zentrale Ausnehmung aufgenommen werden können, dadurch gekennzeichnet, daß die Wände de zentralen Ausnehmung durch freie Endteil von drei Blattfedern (21) gebildet werden, die im wesentlichen unabhängig voneinander federnd sind und deren nicht-freie Enden regelmäßig verteilt um den Umfang der Kupplungsbüchse an der Wand eines die zentrale Ausnehmung umgebenden Gehäuses (3) befestigt sind und wobei die Ebenen der genannten Blatfedern Winkel von etwa 60° miteinander einschließen, wobei die Dicke des Gehäuses gegenüber der Dicke der Blattfedern groß ist.

2. Verbindungselement nach Anspruch 1, dadurch gekennzeichnet, daß jede Blattfeder (21) etwa halbwegs der zentralen Ausnehmung durch einen Schnitt unterbrochen ist, der sich in radialer Richtung von dem freien Ende bis zu etwa der Wand des Gehäuses erstreckt.

3. Verbindungselement nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Blattfedern und das Gehäuse aus einem einzigen Werkstoffteil hergestellt sind.

Revendications

1. Connecteur pour le couplage optique d'au moins une paire de fibres optiques (7), dont les parties terminales sont logées dans des enveloppes (9) qui présentent une surface extérieure en forme de cylindre de révolution (11), lequel connecteur comprend une douille de couplage (3) pour disposer coaxialement au moins les parties terminales libres des deux enveloppes pour coupler optiquement les fibres optiques entre elles par l'intermédiaire de leurs faces terminales (15), laquelle douille de couplage comprend une cavité centrale (19) qui s'étend dans sa direction logitudinale et qui est sous forme d'un prisme dont la section transversale est triangulaire et dont le cercle inscrit (25) présente un diamètre qui est inférieure au diamètre de la surface extérieure (11) de l'enveloppe, les parois de la cavité centrale étant réalisées de façon à être élastiques dans la direction radiale de façon que les enveloppes puissent être serrées dans la cavité centrale, caractérisé en ce que les parois de la cavité centrale sont formées par les parties terminales libres de trois ressorts à lames (21) qui sont à peu près indépendamment élastiques et dont les extrémités non libres sont régulièrement réparties sur la circonférence de la douille de couplage et fixées à la paroi d'un boîtier qui enferme la cavité centrale, les plans desdits ressorts à lames enfermant entre eux des angles d'environ 60° et l'épaisseur du boîtier étant grande comparativement à l'épaisseur des ressorts à lames.

2. Connecteur selon la revendication 1, caractérisé en ce qu'environ à mi-chemin de la cavité centrale, chaque ressort à lames (21) est interrompu par une incision qui s'étend dans la direction radiale à partir de l'extrémité libre à environ la paroi du boîtier.

3. Connecteur selon la revendication 1 ou 2, caractérisé en ce que les ressorts à lames et le boîtier sont réalisés sous forme d'une seule pièce de matériau.

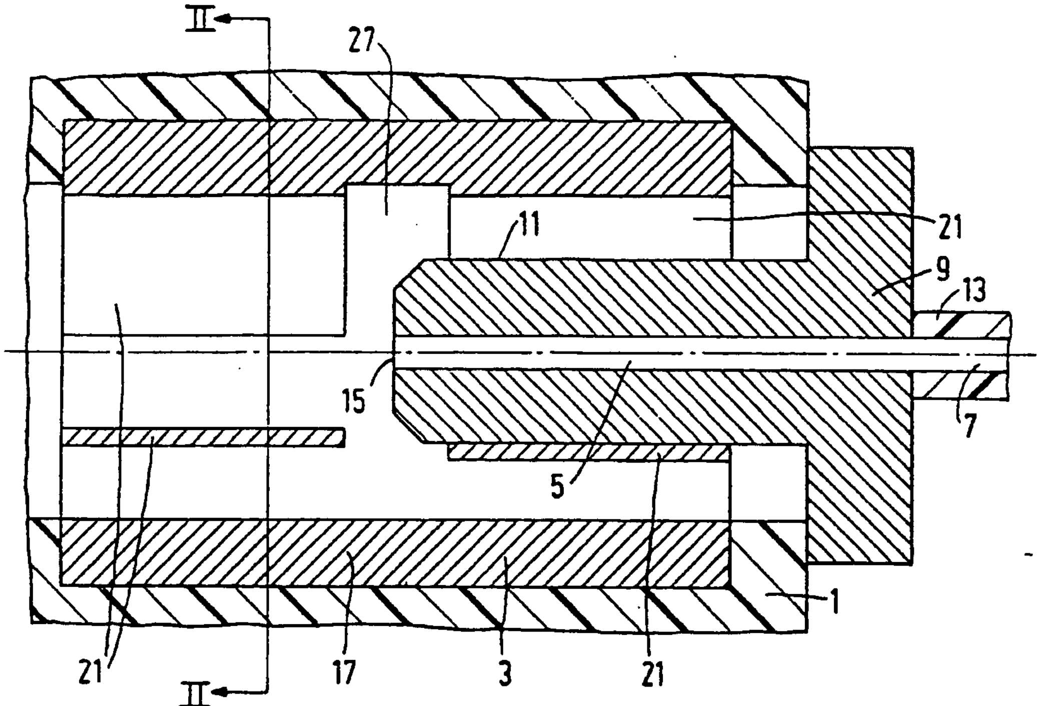

FIG.1

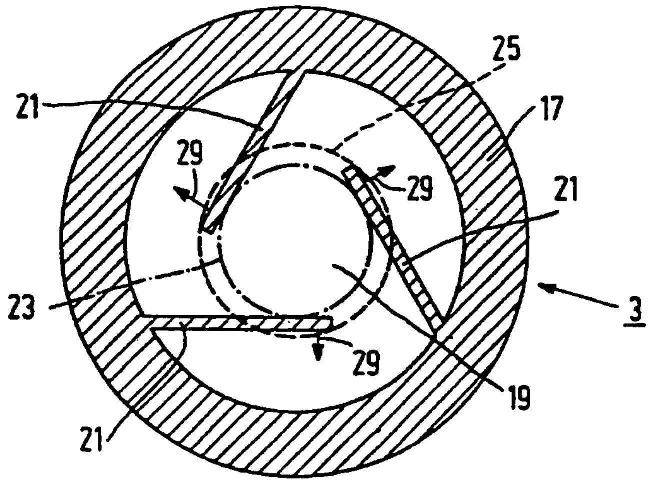

FIG.2